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EPA's (Environmental Protection Agency's) Role in the Quality Assurance of Ambient Air Pollutant Measurements

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EPA's ROLE IN THE QUALITY ASSURANCE OF AMBIENT AIR POLLUTANT MEASUREMENTS

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16. ABSTRACT

Ensuring the quality and integrity of ambient air pollution measurements encompasses a wide variety of activities and procedures. EPA's roll in the quality assurance of monitoring data is to assist monitoring agencies by providing those quality assurance services or functions that (1) are common to most monitoring agencies and would be uneconomical to duplicate in each agency's program, (2) are too costly for individual monitoring agencies to carry out, (3) need to be uniform across the nation's monitoring agencies to facilitate universal data interpretation, comparison, evaluation, and common analysis, or (4) are more appropriately derived from a source independent from the monitoring agency. These functions are focused in three principle areas: (1) standardized and validated monitoring methods, (2) air monitoring guidance and technical assistance, and (3) assessment of the quality of monitoring data being obtained. These functions are discussed along with overview descriptions and summaries of results of specific EPA quality assurance programs including reference and equivalent methods, the Quality Assurance Handbook and other guidance documents, availability of varous pollutant concentration standards, and assessment and reporting of the precision and accuracy of air monitoring data.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Ambient Air Monitoring Quality Assurance Standardized Methods Technical assistance Data quality assessment	Reference and equivalent methods Quality Assurance Handbook Pollutant Standards Precision and accuracy	

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EPA'S ROLE IN THE QUALITY ASSURANCE OF AMBIENT AIR POLLUTANT MEASUREMENTS

Ensuring the quality and integrity of ambient air pollution measurements encompasses a wide variety of activities and procedures. In the various networks of State and Local Air Monitoring Stations (SLAMS), most of these activities are carried out by the state or local agency as a part of their overall data collection process. The role of EPA in this scheme is to assist these monitoring agencies by providing those quality assurance services or functions that (1) are common to most monitoring agencies and would be uneconomical to duplicate in each agency's program, (2) are too costly for individual monitoring agencies to carry out, (3) need to be uniform across the nation's monitoring agencies to facilitate universal data interpretation, comparison, evaluation, and common analysis, or (4) are more appropriately derived from a source independent from the monitoring agency.

Pursuant to these goals, EPA's quality assurance support to states' SLAMS monitoring programs is focused in three principle areas, namely:

1. Provision of standardized and validated monitoring methods,
2. Air monitoring guidance and technical assistance, and
3. Assessment of the quality of monitoring data being obtained.

Taken together, these functions provide the states with a strong, fundamental basis and framework to support and augment their overall quality assurance programs. These functions, along with overview descriptions and summaries of the results of specific associated EPA quality assurance support programs, are discussed in the following sections of this paper. Most of these programs have been developed or evolved over the more than 15 years since the National Ambient Air Quality Standards were first promulgated, and are still subject to continual review, evaluation, and further refinement.

Standardized and Validated Monitoring Methods

Reference and Equivalent Methods

Certainly one of the most important and basic elements in obtaining quality ambient air monitoring data is the use of adequate and reliable monitoring methods. A prominent example of EPA's support in this area is the Reference and Equivalent Method program, administered by the Quality Assurance Division of EPA's Environmental Monitoring Systems Laboratory (EMSL) at Research Triangle Park, NC. This program, established in 1975, defines specific performance and other requirements for monitoring methods used by states in their SLAMS compliance monitoring networks and prescribes detailed test procedures by which the methods must be tested and approved.

Under this program, monitoring methods are categorized as either manual methods--which are characterized by a detailed, step-by-step, manually executed procedure, or automated methods--which are automatic, self-contained analyzers employing an instrumental measurement principle. For each of the criteria pollutants (SO_2, O_3, CO, NO_2, Pb, and TSP), either a manual reference method (SO_2, Pb, TSP) or a reference measurement principle and calibration procedure (O_3, CO, NO_2) is specified in an Appendix to 40 CFR Part 50 of the EPA monitoring regulations. These Appendixes represent pollutant measurement technology that has been extensively tested and known to be adequate for compliance monitoring purposes. In the former case, the reference method is completely specified in the Part 50 Appendix. However, in the latter case (automated methods), analyzers are designated as reference methods only if they (1) employ the measurement principle and calibration procedure specified in the appropriate appendix of Part 50, and (2) demonstrate that they meet performance specifications and other requirements prescribed in the EPA regulation 40 CFR Part 53. Hence, while manual reference methods are unique, there can be (and in fact are) multiple reference methods (analyzer models) for O_3, CO, and NO_2.

Manual monitoring methods different than one of the specified reference methods, or automated methods based on a measurement principle and calibration procedure different than those specified for reference methods, may be designated as equivalent methods.* For use in SLAMS monitoring networks, both reference and equivalent methods are equally acceptable.

Equivalent methods are designated based on their having a "consistent relationship" to a reference method--i.e., an equivalent method must demonstrate that it produces measurements equivalent to measurements by a reference method when both methods measure identical samples of actual ambient air. Automated equivalent analyzers must also meet the same performance specifications that are applicable to reference methods. The basic requirements for manual and automated reference and equivalent methods are summarized in Table 1. The actual performance requirements applicable to both reference and equivalent automated methods are listed in Table 2, and the consistent relationship requirements for equivalent methods are given in Table 3. These and the other requirements for designation of reference and equivalent methods (e.g., content of the instruction manual, adequacy of operation and calibration procedures, approval of modifications, quality assurance of production analyzers offered for sale, etc.) are set forth formally in 40 CFR Part 53 of the EPA monitoring regulations, along with the detailed test procedures for determining whether candidate methods meet the performance specifications.

To date, EPA has designated 60 reference and equivalent methods. These methods, together with the 3 manual reference methods specified in Part 50, are identified officially on the "List of Designated Reference and Equivalent Methods" published by the Quality Assurance Division (Environmental Systems Laboratory, U. S. EPA, Research Triangle Park, North Carolina 27711). This list is distributed to the States, Regional Offices, and other interested monitoring agencies. In addition to processing applications for reference and

*Although there is currently no provision for designating equivalent methods for TSP, proposed amendments to the regulations would provide for designation of both reference and equivalent methods for PM_{10}.

equivalent methods and maintaining the list of designated methods, the Quality Assurance Division (QAD) also reviews and approves proposed modifications to designated methods by either analyzer manufacturers or users, conducts post designation tests or other evaluations of designated analyzers, develops improved methods, adapts new measurement principles and calibration procedures for reference methods, and carries out other related activities.

Besides providing high quality monitoring methodology for determining compliance with the ambient air quality regulations, the reference and equivalent methods program has also provided at least two other important benefits:

1. Flexibility. As soon as new monitoring techniques are developed and demonstrated to pass the requirements, they can be used immediately for pollutant monitoring. There is no need to change existing regulations to incorporate new or improved monitoring methods.

2. Reduced Method Development Costs to EPA. Once the monitoring method requirements were promulgated in the Code of Federal Regulations, EPA funds were no longer required to develop monitoring methods for the criteria pollutants. Instrument manufacturers generally have assumed the burden to both develop the methods and demonstrate their acceptability, allowing EPA to apply its resources elsewhere.

Other Method Standardization Activities

The Quality Assurance Division carries out many other method standardization activities for non-criteria pollutants, as well. These activities have recently included developing a new, more sensitive and accurate method for monitoring ambient concentrations of nonmethane organic compounds, publishing a "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air" (EPA-600/4-84-041), assisting in the standardization of methods for measuring asbestos in the air, and participating in the development of an agencywide guideline for validating environmental monitoring methods of all types.

Guidance and Technical Assistance

Availability of adequate, standardized monitoring methods is of little benefit if those methods are not used correctly and conscientiously by knowledgeable analysts. Consequently, the QAD has long recognized the need for supplemental instruction and guidance to accompany the methods widely used for ambient monitoring. Expertise and experience gained in the development, standardization, and use of monitoring method must be passed on to method users to optimize the quality and usefulness of the data obtained.

Quality Assurance Handbook

One particularly comprehensive guidance document for this purpose is QAD's Quality Assurance Handbook. First published in 1976, this detailed document containing both general and specific quality assurance procedures and information has been continually expanded, refined, and updated over the years and has

become the "QA bible" among monitoring agencies and other users of the most popular methods for monitoring the criteria pollutants and other environmental parameters.

The Quality Assurance Handbook currently consists of five volumes, identified in Table 4. Volume I is devoted to basic, general principles of quality assurance. The subsequent volumes of the Handbook cover media-specific general topics and method-specific aspects of many of the most widely used methods. General aspects of quality assurance applicable to ambient air monitoring systems (Section 2.0) and the specific ambient air methods are covered in Volume II. Similarly, general topics and specific methods for stationary source monitoring methods are covered in Volume III. In general, an entire section of the Handbook is devoted to each of the methods covered. The comprehensive scope of each of these method-specific sections is indicated by the list of topics for a typical method-specific section shown in Table 5.

Other Guidance and Technical Assistance

Over the years QAD has issued a great deal of technical assistance to the user community in the form of technical reports, instruction manuals, status reports, guidance documents, seminars, symposia, workshops, and telephone assistance. Of particular interest is a series of comprehensive technical publications called Technical Assistance Documents. The currently available Technical Assistance Documents are identified in Table 6. Each of these Technical Assistance Documents contains an in-depth discussion of specific and particularly complex areas of ambient monitoring and provides detailed guidance and instruction and, where appropriate, specific procedures needed for effective quality assurance in these areas. These TAD's are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161 (703-487-4650).

Pollutant standards

Calibration and audit standards are of obvious and primary importance to quality assurance of pollution measurements. Development of appropriate and practical pollutant concentration standards of adequate accuracy, reliability, and availability has been a consistently high priority QAD project since the earliest needs for air pollutant measurements. Associated needs for calibration equipment, systems, devices, procedures, and verification techniques have also been addressed.

A fundamental need for primary gaseous pollutant concentration standards has been largely met by the availability of Standard Reference Materials (SRM's) from the National Bureau of Standards (NBS). Most EPA regulations require that pollutant concentration standards be traceable to such NBS primary standards. However, the cost and very limited supply of NBS SRM's makes them inappropriate for direct use by the many agencies and programs needing NBS-traceable standards. To alleviate this problem, NBS and EPA have jointly established a program to

allow gas manufacturers to produce and sell high quality gas concentration standards called Certified Reference Materials (CRM's). These CRM's are prepared and certified according to explicit CRM procedures developed by NBS and EPA and are considered equivalent to SRM's for purposes of establishing traceable working standards used for calibration and audits. Many of the EPA monitoring regulations have been amended to specifically allow working pollutant standards to be traceable to a CRM in lieu of an SRM.

The CRM certification procedure requires that a gas manufacturer first prepare a batch of ten or more standard cylinders, all having the same concentration, which must be within 1 percent of an appropriate SRM. From this batch, the manufacturer selects at least 10 cylinders, which are tested for homogeneity. The batch of standards are then stored for at least two months (one month for CO standards), after which time all cylinders are reanalyzed to demonstrate stability and to determine the assay concentration for the batch. Two cylinders are selected at random for audit analysis by EPA. The results of all tests--including the EPA tests--are then sent to NBS to determine whether the entire batch of standards qualifies to be sold as CRM's. If so, each standard cylinder sold from the batch is accompanied by joint NBS/EPA documentation listing the pertinent assay information and authenticating the cylinder as a CRM. A current list of CRM's is available from The Quality Assurance Division (MD-77), Environmental Monitoring Systems Laboratory, U. S. Environmental Protection Agency, Research Triangle Park, NC 27711.

As noted above, all gaseous pollutant standards used for calibration and auditing in state compliance networks are required to be traceable to either an NBS SRM or a CRM. The definition of "traceable" allows no more than one intermediate standard between the primary standard (SRM or CRM) and the field working standard.

The two most commonly used types of gaseous pollutant standards are cylinders of compressed gas and permeation devices. Procedures for certifying a working standard cylinder against a primary standard cylinder, and a working standard permeation device against either a primary standard cylinder or a primary standard permeation device are provided in Section 2.0.7 of the Quality Assurance Handbook (Volume II). Basically, these procedures give detailed guidance for setting up special certification systems designed to minimize comparative error, methods for precise calibration of analytical equipment, techniques for accurate comparisons of the two standards, appropriate tests for stability, and recommended recertification requirements. This section is currently under revision, and the updated version of these certification procedures should be available soon.

One criteria pollutant for which no SRM is available is ozone. Because of their instability, ozone concentration standards must be generated and certified locally as needed. In another joint EPA-NBS program, a highly stable, very precise, computer-controlled Standard Reference Photometer has been developed to assay ozone concentration standards and serve as a primary NBS reference standard for ozone. EPA has established a network of these Standard Reference

Photometers, currently consisting of the six locations listed in Table 7. Two additional locations are scheduled for installation in 1987. This network provides a means for state and local air monitoring agencies to compare their ozone standards to an authoritative primary ozone standard maintained and operated under closely controlled conditions. Such comparisons may be used to verify the accuracy of the agency's own local primary ozone photometer, verify certified transfer standards, or (in some cases) to certify transfer standards. The Network also provides EPA with information to assess the nationwide reliability and comparability of local ozone standards.

Two additional Standard Reference Photometers, one located at NBS and the other located at EPA/Research Triangle Park (EPA/RTP) are also maintained and directly intercompared once each year. The NBS instrument serves as a primary reference for NBS and is used to certify new Standard Reference Photometers. The EPA unit is used to recertify the network instruments by direct intercomparison each year, using a recertification protocol developed jointly by EPA and NBS. This protocol requires (1) initial comparison of the EPA primary standard with the RTP Network instrument, (2) comparison of the EPA standard with each of the Network instruments at the Network site, and (3) final recomparison of the EPA standard with the RTP Network instrument. Each recertification comparison requires simultaneous assays by each instrument of 3 sets of 12 ozone concentrations between 0 and 1000 ppb, with each concentration being assayed at least 9 times. Target specifications for these recertification comparisons are 1 percent agreement for the regression slope and 3 ppb agreement for the intercept. The recertification data for each recertification are submitted to NBS for review, and if acceptable, an official NBS recertification document for the instrument is issued. All recertifications to date have met the target specifications.

The Standard Reference Photometer Network also provides data on the comparisons of state and local agencies' photometers and transfer standards to the Network Standard Reference Photometer. To date, results of these comparisons have been reported for 55 verifications of local primary standards and for 31 verifications of certified transfer standards. These results are listed in Tables 8 and 9. Forty-six of the local primary standards (84%) were within the established acceptable range of 3 percent agreement for primary standards, and all 31 of the transfer standards (100%) were within the 5 percent agreement established as acceptable for transfer standards.

Performance Assessment

The third major area of quality assurance support by QAD for state and local monitoring agencies is assessment and evaluation of the quality of the monitoring data being routinely collected. With the establishment in 1979 of regulations prescribing uniform requirements for monitoring network design, siting, monitoring methods, quality assurance, and reporting methods (40 CFR Part 58), the quality of monitoring data reported could finally be documented in a uniform and meaningful way. These data quality assessments can now be used for much more reliable interpretation and evaluation of the air pollutant measurements being obtained.

Precision and Accuracy Reporting System

The data quality assessment provisions in Part 58 (Appendix A) of the monitoring regulations specify explicit requirements for how each type of measurement system is to be assessed, how often, and how the results are to be reported. Data quality is defined primarily in terms of accuracy and precision. Accuracy is generally assessed (audited) by introducing NBS-traceable pollutant concentration standards into the measurement system and comparing the measured value to the true (standard) concentration. In some cases (such as for particulate matter), pollutant standards cannot be obtained for field use, and therefore only a portion of the measurement system (such as the flow metering system) can be reasonably audited.

Precision is assessed by comparing replicate measurements from the measurement system. For automated methods (analyzers), a fixed, low-level concentration standard is measured at least biweekly. For manual methods, simultaneous replicate measurements are obtained from duplicate (collocated) samplers operated periodically. The specific requirements and procedures used vary somewhat to accommodate the different pollutants and different types of measurement methods. Table 10 summarizes the current minimum data assessment requirements for SLAMS monitoring networks.

Precision and accuracy estimates are first calculated for each measurement system and then averaged over each calendar quarter. These estimates are then combined with the estimates from all of the similar measurement systems in each Reporting Organization to form composite estimates of precision and accuracy for the Reporting Organization. A Reporting Organization is defined as a state, subordinate organization within a state, or other organization that is responsible for a set of monitoring stations that monitor the same pollutant and for which precision or accuracy assessments can be appropriately pooled. The composite precision and accuracy estimates representing all the similar measurement systems in the reporting organization are expressed as 95 percent probability limits forming a probability interval. The upper and lower probability limits are determined as the mean value plus and minus 1.96 times the standard deviation.

Prior to 1986, states were required to calculate and report these composite or integrated precision and accuracy estimates for each of their reporting organizations. However, the regulations have been modified in 1986 to instead require the states to report the individual results from each precision or accuracy test carried out and from all collocated measurements obtained. EPA (EMSL) will then calculate the pooled average precision and accuracy 95 percent probability limits for each reporting organization. This change will allow EPA to have access, for the first time, to the individual precision and accuracy test results for each measurement system. This will facilitate detailed analysis of the data quality at specific sites or types of sites, for specific methods or types of methods, under specific conditions, etc. This additional information will greatly augment the description of specific blocks of the SLAMS monitoring data and allow more detailed analysis and utilization of the data. The more detailed information will also be useful for monitoring the performance or adequacy of specific methods or types of monitoring instruments.

Precision and accuracy information for SLAMS monitoring networks is currently available for the years 1981 through 1984.* The completeness of the data reported is shown in Table 11. Table 12 lists the percent of reporting organizations reporting probability intervals (absolute difference between the upper and lower 95 percent probability limits) less than 21 percent and less than 31 percent for years 1981, 1982, and 1983. In general, these tables show continued improvement in data quality for the SLAMS network.

National Performance Audit Program

Another data quality assessment facility established with the 1979 monitoring regulations in 40 CFR 58, Appendix A was the National Performance Audit Program. This program provides assessments of SLAMS routine monitoring data accuracy similar to those obtained in the precision and accuracy reporting system, but with a greater degree of independence. Under this program, in which SLAMS monitoring agencies are required to participate, standards or test materials whose concentration or value is unknown to the analyst or to the participating agency are supplied by EPA. Measurements of the test materials are returned to QAD for determination of the performance results. The greater independence of this assessment provides an important check on the validity of the more detailed information from the precision and accuracy reporting system. Table 13 indicates the types of measurement systems covered by the National Performance Audit Program and the number of audits conducted each year. Results from this audit program are available for 1981 through 1984.*

Regional Systems Audits

A third key program in EPA's quality assurance support efforts is the program of systems audits of SLAMS monitoring programs. This program of systems audits is also authorized by the monitoring regulations in 40 CFR 58, Appendix A. A systems audit is a complete and thorough inspection, review and evaluation of a state or local agency's ambient air monitoring program to assess its compliance with established regulations governing the collection, analysis, validation, and reporting of ambient air quality data. A systems audit of each state or autonomous agency within an EPA Region is carried out annually by a member of the Regional Quality Assurance (QA) staff. Included in the systems audit are appraisals of such areas as monitoring network design and management, resources and facilities, field operations, laboratory operations, data management and reporting, quality control, and data quality assessment and reporting. This comprehensive review of the entire monitoring system helps to reveal problem areas that may limit or compromise data quality, and provides specific guidance and instruction directly to the agency for any corrective actions or improvements needed.

*R. C. Rhodes and E. G. Evans, "Summary of Precision and Accuracy Assessments for State and Local Air Monitoring Networks, 1981", June 1983, EPA 600/4-84-032; R. C. Rhodes and E. G. Evans, "Summary of Precision and Accuracy Assessments for State and Local Air Monitoring Networks, 1982", April 1985, EPA 600/4-85-031; R. C. Rhodes and E. G. Evans, "Precision and Accuracy Assessments for State and Local Air Monitoring Networks, 1983", February 1986, EPA 600/4-86-012; R. C. Rhodes and E. G. Evans, "Precision and Accuracy Assessments for State and Local Air Monitoring Networks, 1984, (Publication imminent).

Summary

EPA plays a key role in the quality assurance program for ambient air measurements in three major areas:

1. Providing standardized and validated monitoring methods,
2. Providing monitoring guidance and technical assistance, and
3. Conducting assessments of the quality of the monitoring data.

While state and local air monitoring agencies carry out the monitoring and quality control programs necessary to collect the ambient data, effective team work between EPA and the air monitoring agencies ensures the high quality of those monitoring data.

Table 1. General Requirements for Reference and Equivalent Methods

	REFERENCE METHOD	EQUIVALENT METHOD
Manual	None	Consistent Relationship Test (Subpart C)
Automated	1. Specified measurement principle and calibration procedure 2. Lab performance tests (Subpart B) 3. No automated reference methods designated if reference method is a manual method	1. Lab performance tests (Subpart B) 2. Consistent Relationship Tests (Subpart C)

Table 2. Performance Specifications for Automated Methods

Performance Parameter	Units	SO_2	O_3	CO	NO_2
1. Range	ppm	0-0.5	0-0.5	0-50	0-0.5
2. Noise	ppm	0.005	0.005	0.50	0.005
3. Lower Detectable Limit	ppm	0.01	0.01	1.0	0.01
4. Interference Equivalent					
Each interferent	ppm	± 0.02	± 0.02	± 1.0	± 0.02
Total interferent	ppm	0.06	0.06	1.5	0.04
5. Zero drift, 12 and 24 hr.	ppm	± 0.02	± 0.02	± 1.0	± 0.02
6. Span drift, 24 hr.					
80% of upper range limit	Percent	± 20.0	± 20.0	± 10.0	± 20.0
20% of upper range limit	Percent	± 5.0	± 5.0	± 2.5	± 5.0
7. Lag time	Minutes	20	20	10	20
8. Rise time	Minutes	15	15	5	15
9. Fall time	Minutes	15	15	5	15
10. Precision					
20% of upper range limit	ppm	0.01	0.01	0.5	0.02
80% of upper range limit	ppm	0.015	0.01	0.5	0.03

Table 3. Test Requirements for the Consistent Relationship Test for Equivalent Methods

Pollutant	Concentration Range	Simultaneous Measurements Required				Maximum Discrepancy Specification, ppm
		1 Hour		24 Hour		
		1st set	2nd set	1st set	2nd set	
Ozone	Low 0.06-0.10	5	6	-	-	0.02
	Med 0.15-0.25	5	6	-	-	0.03
	High 0.35-0.45	4	6	-	-	0.04
	Total	14	18			
Carbon Monoxide	Low 7-11	5	6	-	-	1.5
	Med 20-30	5	6	-	-	2.0
	High 35-45	4	6	-	-	3.0
	Total	14	18			
Sulfur	Low 0.02-0.05	-	-	3	3	0.02
	Med 0.10-0.15	-	-	2	3	0.03
	High 0.40-0.50	7	8	2	2	0.04
	Total	7	8	7	8	
Nitrogen Dioxide	Low 0.02-0.08	-	-	3	3	0.02
	Med 0.10-0.20	-	-	2	3	0.02
	High 0.25-0.35	-	-	2	2	0.03
	Total			7	8	

Table 4. Quality Assurance Handbook Volumes

Volume	Title	EPA Publication Number
I	Principles of QA	EPA 600/9-76-005
II	Ambient Air Methods	EPA 600/4-77-027a
III	Stationary Source Methods	EPA 600/4-77-027b
IV	Meteorological Monitoring	EPA 600/4-82-060
V	Precipitation Measurements	EPA 600/4-82-042a & b

Table 5. Outline of a Typical Method-Specific Section

1. Procurement of Equipment and Supplies
2. Calibration of Equipment
3. Operation and Procedure
4. Data Reduction, Validation and Reporting
5. Maintenance
6. Auditing procedure
7. Assessment of Monitoring Data for Precision and Accuracy
8. Recommended Standards for Establishing Traceability
9. Complete Method Description
10. References
11. Data Forms

Table 6. List of Technical Assistance Documents Available

Title	Author(s)	EPA No.	NTIS Stock No.	Approx. Cost
Technical Assistance Document for the Chemiluminiscence Measurement of Nitrogen Dioxide	E. C. Ellis	EPA-600/4-75/003	PB268456	$ 9.50
Use of the Flame Photometric Detector Method for Measurement of Sulfur Dioxide in Ambient Air	W. C. Eaton	EPA/600/4-78-024	PB285171	14.00
Technical Assistance Document for the Calibration of Ambient Ozone Monitors	R. J. Paur F. F. McElroy	EPA-600/4-79-057	PB80-149552	8.00
Transfer Standards for Calibration of Ambient Air Monitoring Analyzers for Ozone	F. F. McElroy	EPA-600/4-79-056	PB80-146871	14.00
Technical Assistance Document for the Calibration and Operation of Automated Ambient Non-methane Organic Compound Analyzers	F. W. Sexton R. M. Michie, Jr. F. F. McElroy V. L. Thompson	EPA-600/4-81-015		
Investigation of Flow Rate Calibration Procedure Associated with the High Volume Method for Determination of Suspended Particulates	F. Smith P. S. Wohlschegel R. S. C. Rogers	EPA-600/4-78-047	PB291386	14.00
Technical Assistance Document for Sampling and Analysis of Toxic Organic Compounds in Ambient Air	R. M. Riggin	EPA-600/4-83-027	PB83-239020	16.95

Table 7. EPA Standard reference photometer network.

SRP site	SRP #	Participating agency	Installation date
RTP, N.C.	1	U.S. EPA - EMSL/RTP	June 1984
Edison, N.J.	3	U.S. EPA - Region II	August 1984
Sacramento, CA.	4	Calif. Air Resources Board	September 1984
Chicago, IL.	6	U.S. EPA - Region V	March 1985
Houston, TX.	5	U.S. EPA - Region VI	May 1985
Denver, CO.	8	U.S. EPA - Region VIII	March 1986

Table 8. Verification of primary O_3 standards (photometers)

Model	Number of comparisons	Number of units	Number of comparison results within indicated agreement			
			0-1%	1-2%	2-3%	>3%
Dasibi 1003	26	15	10	8	6	2
Dasibi 1008	22	19	7	6	2	7
CSI 3000	5	4	2	3	-	-
TECO 49PS	2	2	1	1	-	-
Totals:	55	40	20	18	8	9[a]

[a] 5 comparison results > 5%

Table 9. Verification of O_3 transfer standards

Model (type)	Number of comparisons	Number of units	Number of comparison results within indicated agreement			
			0-1%	1-2%	2-3%	3-5%
Dasibi 1003 (photometer)	11	8	4	5	2	-
Dasibi 1003 (analyzer)	2	2	2	-	-	-
Dasibi 1008 (photometer)	12	6	3	3	5	1
TECO 49PS (photometer)	4	2	1	-	2	1
Monitor Labs 8810 (analyzer)	1	1	1	-	-	-
Monitor Labs 8500 (generator)	1	1	1	-	-	-
Totals:	31	20	12	8	9	2

Table 10. Minimum Data Assessment Requirements

Method	Assessment Method	Coverage	Minimum Frequency	Parameters Reported
		PRECISION		
Automated methods for SO_2, NO_2, O_3, and CO	Response check at concentration between .08 and .10 ppm (8 & 10 ppm for CO)	Each analyzer	Once per 2 weeks	Actual concentration and measured (indicated) concentration
Manual methods including lead	Collocated samplers	1 site for 1-5 sites 2 sites for 6-20 sites 3 sites for > 20 sites (sites with highest conc.)	Once per week	Two concentration measurements
		ACCURACY		
Automated methods for SO_2, NO_2, O_3, and CO	Response check at .03-.08 ppm* .15-.20 ppm* .35-.45 ppm* .80-.90 ppm* (if applicable) *Conc. X 100 for CO	1. Each analyzer 2. 25% of analyzers (at least 1)	1. Once per year 2. Each calendar quarter	Actual concentration and measured (indicated) concentration for each level
Manual methods for SO_2 and NO_2	Check of analytical procedure with audit standard solutions	Analytical system	Each day samples are analyzed, at least twice per quarter	Actual concentration and measured (indicated) concentration for each audit solution
TSP	Check of sampler flow rate	1. Each sampler 2. 25% of samplers (at least 1)	1. Once per year 2. Each calendar quarter	Actual flow rate and flow rate indicated by the sampler
Lead	1. Check sample flow rate as for TSP 2. Check analytical system with Pb audit strips	1. Each sampler 2. Analytical system	1. Include with TSP 2. Each quarter	1. Same as for TSP 2. Actual concentration and measured (indicated) concentration of audit samples (μg Pb/strip)

Table 11. Percent Completeness of Precision and Accuracy Data for SLAMS

Pollutant	1981	1982	1983	1984
CO	77	89	91	89
SO_2	82	93	89	92
NO_2	56	72	84	86
O_3	83	89	91	90
TSP	94	97	98	97
Pb			81	82

Table 12. Percent of SLAMS Reporting Organizations with 95% Probability Intervals[a] Less than 21% and 31%

	1981		1982		1983	
	<21%	<31%	<21%	<31%	<21%	<31%
	Precision					
CO	78	92	82	96	87	98
SO_2	41	78	40	83	46	88
NO_2	36	70	40	71	40	85
O_3	59	87	62	91	62	93
TSP	45	73	43	74	50	80
Pb	--	--	46	59	39	64
	Accuracy					
CO	75	88	86	94	84	94
SO_2	48	70	49	86	54	76
NO_2	50	76	49	70	56	76
O_3	63	87	72	87	75	91
TSP	86	97	78	95	90	97
Pb	--	--	87	100	89	98

[a] Probability interval = upper limit - lower limit

Table 13. National Performance Audit Program Annual Schedule

Pollutant	No. of Audits
SO_2 - Bubbler	1
NO_2 - Bubbler	1
CO - Monitor	2
SO_2 - Monitor	Continuous
NO_2 - Monitor	Continuous
SO_4 - (Filters)	2
NO_3 - (Filters)	2
Pb - (Filters)	2
High-Volume (Flow)	1
Acid rain	2